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Title:	Current and Future Work on Wound Contamination by Alpha Emitters at Los Alamos
Author(s):	Klumpp, John Allan
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Current and Future Work on Wound Contamination by Alpha Emitters at Los Alamos

John Klumpp, PhD, CHP
Internal Dosimetry Program Lead
Los Alamos National Laboratory

jaklumpp@lanl.gov

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Past Work on Pu Wound Modeling

- ICRP does not define wound models or provide dose coefficients for wounds
- NCRP developed wound models corresponding to animal model wound scenarios
- These can be fit into ICRP systemic models to calculate dose coefficients
- Our team developed attempted to apply NCRP wound models to data:
  - -NCRP models needed modification (sometimes major) to fit all the data
  - -A linear combination of NCRP models fits many cases
  - *-a simplified wound model with variable transfer rates was developed which fits a wide range of empirical data*

Past Work on Pu Wound Modeling (Chelation)

- Doses are traditionally calculated by discarding data assumed to be affected by chelation (in U.S., three months after last treatments)

- Empirical models have been used to estimate the ‘benefit’ of chelation treatments (doses saved) for several LANL cases

- Modified CONRAD model has also been used to simultaneously fit affected and unaffected data

- Objective is to calculate the doses while treatment is ongoing

Ongoing Work – Treatment Decisions

- *Our team calculated 'clinical decision levels' at which treatment may be warranted* (i.e., bioassay and wound measurements which correspond to specific dose thresholds)

- The actual risk to the patient corresponding to this dose threshold is uncertain – the CED may not tell the whole story

- We recently reviewed LANL medical records to characterize adverse events associated with treatment

- **Future work:**
  - **-Include medical records from other institutions**
  - **-Review and analyze data to quantify benefit of treatment – what factors predict whether treatment will be beneficial?**

Future Work – Skin Dosimetry/Predicting Deterministic Effects

- Severe local effects from Pu contaminated wounds have been observed (e.g., Lushbaugh and Langham 1962)
- NCRP recommends using dosimetry models for shallow or penetrating wounds to estimate local doses to the wound site – what models? What does ‘local’ mean?
- NCRP 156 recommends local doses be limited in the same way as that for “hot particles” described in NCRP 130 – i.e., preclusion of the development of ulcers that would compromise the integrity of the skin as a barrier to infection”
- Another consideration: metallic implants have the potential to induce sarcomas – this possibility should also be considered
- We don’t know how to predict whether a given wound will result in such effects

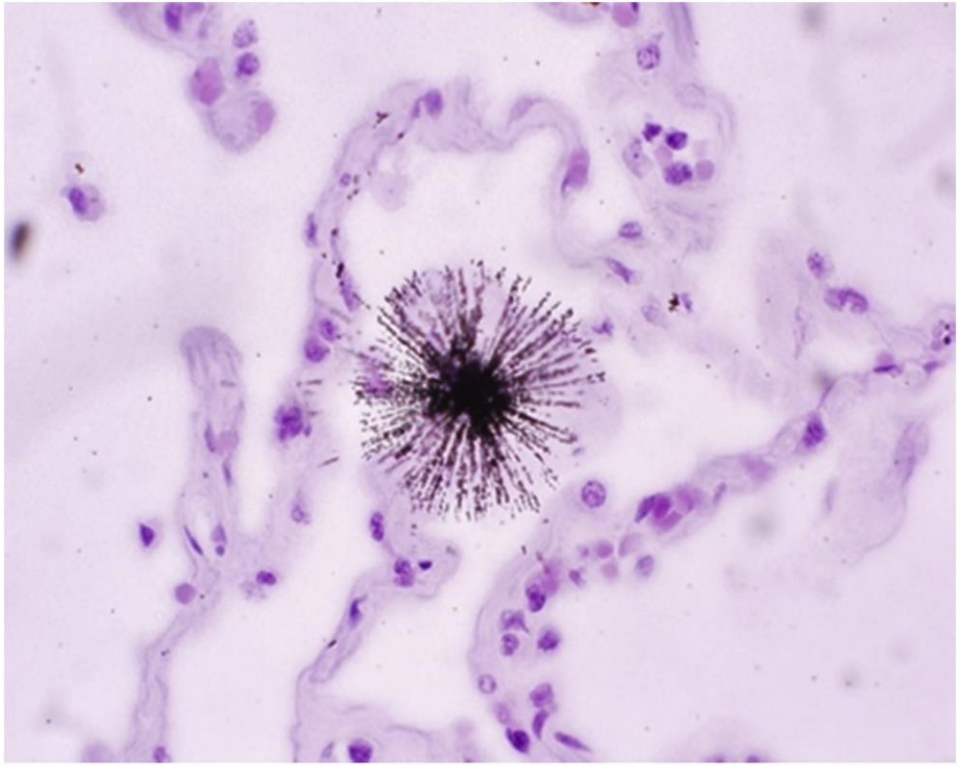
Why Alpha Emitters in Wounds are Different

- Alphas only travel ~40 microns in tissue
- This is not usually enough to penetrate dead outer later of skin (but there are exceptions) – convenient assumptions about geometry do not apply
- Irradiated region closely maps the geometric distribution of alpha emitters in the wound
- Irradiated volume may vary tremendously depending on how diffuse the material is (self-shielding absorbs most alphas from larger particles)
- Larger particles may become very hot depending on specific activity

Past Work – Modeling Pu Dose to Respiratory Tract

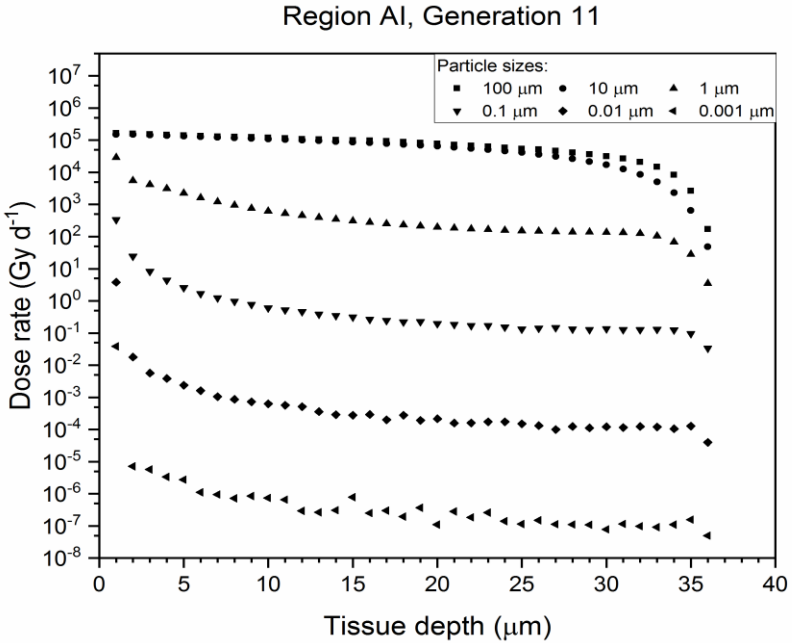
- Somewhat analogous to modeling dose to skin
- Inhaled Pu is deposited as discrete particles – the dose to irradiated lung tissues is much higher than to total lungs
- Dose to irradiated tissues depends on size of deposited particles; dose to total lung also depends on number of particles inhaled
- Long-term retention likely due to encapsulation of undissolved Pu particles in scar tissue

The mass of irradiated tissues is much smaller than the total mass of lungs



Autoradiograph of Pu in lung (Romanov et al 2020)

Local dose rates around Pu particles in lung



Diameter [μm]	Activity [Bq]
100	1.68E+04
10	1.68E+01
1	1.68E-02
0.1	1.68E-05
0.01	1.68E-08
0.001	1.68E-11

Left: Dose rates in the alveolar-interstitial region of the lungs, generation 11 of the tracheobronchial tree, as a function of distance perpendicular to the surface of impacted spheres. Right: Total activity of ^{239}PuO spheres. Due to self-absorption, not all activity escapes spheres. (Ref. Hetrick and Klumpp, manuscript in preparation).

Future Work

- Apply the methods used on lung dosimetry to the NCRP wound models
- Characterize the dose/dose distribution from different categories of wounds
- Compare results against cases of Pu-induced skin lesions
- Attempt to better understand conditions in which lesions occur